Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

# THE OHIO RIVER FLOODS OF 1913[1]

By **ROBERT M. BROWN**
State Normal School, Worcester, Mass.

*The Storms of March 22–27, 1913, in Ohio.* During the five days, March 22–27, 1913, an unprecedented rainfall over the state of Ohio added approximately 560,000,000,000 cubic feet of water to an area where the rivers were somewhat above the normal stage and where the ground, saturated from previous rains, yielded a large percentage of run-off. This volume of water is equivalent to one thirty-sixth the average annual discharge of the Mississippi River, and eight basins as large as the Salt River reservoir would not be sufficient to impound the water.

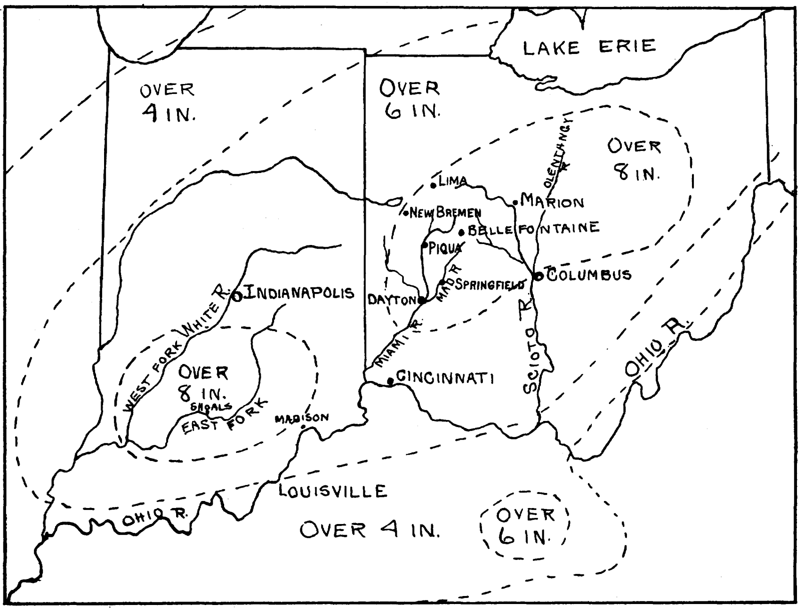

FIG. 1—Map of Ohio and Indiana, showing the amount of rainfall over the district during the passage of the two storms of March 22-27, 1913.

A special bulletin[2] of the Weather Bureau shows that the almost continuous rains of the five days were the resultant of two storms. The first of these, the tornadic storm of Omaha, Nebr., Terre Haute, Ind., and intermediate places, caused precipitation over Ohio during the 23d and 24th, which was excessive. In the Miami River water-shed the rainfall for the 23d at New Bremen was 2.06 inches, at Bellefontaine, 1.37 inches, and at Lima, 2.20 inches; for the 24th at New Bremen, 1.80 inches, at Bellefontaine, 1.52 inches, and at Lima, 1.34 inches, making for this storm at the three stations totals of 3.86 inches, 2.89 inches and 3.54 inches, respectively. Directly upon the rear of this storm from the west, so that the rainfall blended, a storm from the southwest added still heavier precipitation to the already flooded area. The precipitation for the 25th at New Bremen was 3.22 inches, at Bellefontaine, 5.61 inches, and at Lima, 3.35 inches, and, for the 26th, at New Bremen, 1.22 inches, Bellefontaine, 2.13 inches, and Lima, 0.62 inches. The heaviest rainfall reported for the two storms of five days' duration was at Bellefontaine, Ohio, a total of 11.16 inches; Marion, Ohio, reported 10.60 inches; Bangerville, Ohio, Madison and Shoals, both in Indiana, reported over 9 inches; and a large section of the state of Ohio, including all the water-shed drained by the Miami River, experienced over 8 inches. The heaviest rainfall for a single day was at Bellefontaine on the 25th, when 5.61 inches fell; on the same day at Marion 4.71 inches were reported.

---

[1] The writer has made free use of the reports from the various districts by the local engineers, published in the *Engineering Record* and *Engineering News*. The rainfall data have in almost all cases been taken from the daily Weather Maps and the National Monthly Weather Bulletin of the Weather Bureau.

[2] U. S. Dept. of Agriculture Special Bulletin of the Storms of March 22–27, 1913 (published April 15, 1913).

The rainfall, in inches, for January, February and March, 1913, over the Ohio valley for three stations on the southern tributaries and three stations on the northern tributaries with three stations on the Lower Mississippi is shown in Table I.

TABLE I

| | January | | February | | March | |
|---|---|---|---|---|---|---|
| | Normal | 1913 | Normal | 1913 | Normal | 1913 |
| Nashville, Tenn | 4.85 | 12.30 | 4.32 | 4.71 | 5.44 | 4.54 |
| Lexington, Ky | 3.83 | 10.35 | 3.23 | 2.61 | 4.72 | 6.04 |
| Louisville, Ky | 3.90 | 9.91 | 3.75 | 2.09 | 4.32 | 7.70 |
| Cincinnati, O | 3.36 | 9.02 | 3.24 | 1.86 | 3.64 | 9.09 |
| Dayton, O | 3.01 | 6.66 | 3.08 | 1.32 | 3.45 | .... |
| Columbus, O | 2.95 | 6.63 | 3.07 | 2.09 | 3.21 | 8.09 |
| Memphis, Tenn | 5.21 | 7.70 | 4.35 | 5.23 | 5.77 | 4.78 |
| Vicksburg, Miss | 5.67 | 7.00 | 4.61 | 7.31 | 6.25 | 6.70 |
| New Orleans, La | 4.63 | 5.71 | 4.47 | 2.19 | 5.30 | 4.94 |

The rise of the Ohio and Mississippi Rivers in January is accounted for by the excess of rain over the Ohio basin. For the most part during February the rainfall was below the normal for many stations, and in no case did the rainfall for the month greatly exceed the normal. Most of the excess of rain for March, 1913, can be accounted for by the two storms occurring between March 23d and 27th. Thus, at Cincinnati the total rainfall for the month of March was 9.09 inches while the four-day period, 24th to 27th inclusive, yielded 5.19 inches, and at Columbus the total for March and the amount of precipitation during the same four days read 8.09 inches and 6.94 inches, respectively. The daily rainfall for a number of stations is tabulated in Table II. The values are given in inches for the twenty-four hours ending at 8 a.m. on the dates which head the table.

TABLE II

| | March 24 | March 25 | March 26 | March 27 | Total |
|---|---|---|---|---|---|
| Cincinnati, O. | 0.40 | 2.24 | 1.75 | 0.80 | 5.19 |
| Cleveland, O. | 1.96 | 2.88 | 1.26 | 0.98 | 7.08 |
| Columbus, O. | 0.60 | 2.62 | 2.72 | 1.00 | 6.94 |
| Dayton, O. | 0.48 | 2.52 | 2.00 | .40 | 5.40 |
| Indianapolis, Ind. | 1.52 | 3.40 | 0.46 | .... | .... |
| Cairo, Ill. | 0.72 | 1.56 | 2.72 | 0.26 | 5.26 |

*Flood Conditions in Three Cities:* (*a*) *Dayton, Ohio.* Dayton is situated on the Miami River. Within the city limits two large tributaries enter the Miami River, the Mad River and the Stillwater River, and these three streams have a drainage area of nearly 2,500 square miles. The Miami River is bordered on both sides by a flood-plain which is protected by levees. At least one-half of the city of Dayton is on this flood-plain, and the levees which protect this area have been built to withstand a stage of 23 feet. The record flood of the river previous to 1913 was in 1866, when the river reached a stage of 21.3 feet, so that the 23-foot stage was within the generally accepted limit for safety. The only odium which can be attached to the city site lies in the statement that the Miami, notwithstanding the addition of two large tributaries, flows in a narrower channel below the confluences than it does above, and also that the river makes a sharp bend within the city limits; both of these factors would tend to retard the excess discharge. A number of bridges cross the river, and the channel, which averages about 600 feet, was in some cases constricted at these points. None of these, however, can be considered other than aggravating conditions; the main cause of the damage was the rainfall much in excess of any within the experience of residents in the state.

The rise of the river began during the first of the two storms and reached an ordinary flood proportion. For the two-day period ending March 24th the rainfall at Piqua on the Miami River reached 6.59 inches. The drainage of this excessive rainfall was causing a rising stage on the river when the second storm broke and exceeded the precipitation of the first. For the three-day period ending March 27th, Bellefontaine had a rainfall of 8.27 inches and Springfield on the Mad, 6.14 inches. The stage of the flood crest at Dayton was 29 feet, 6 feet above the top of the levees. The overflow began on the 25th, and the recession of the water began on the next day. The lower part of the city was, during the height of the flood, 10 feet under water. Nine breaks in the Mad River levee and the same number on the Miami River resulted. Of the six bridges across the Mad River but one was seriously damaged; the bridges over the Miami suffered more, one was carried away, two badly twisted and all more or less damaged. The loss in human life, while large, was not nearly so overwhelming as first reported and the property loss is conservatively estimated at $30,000,000.

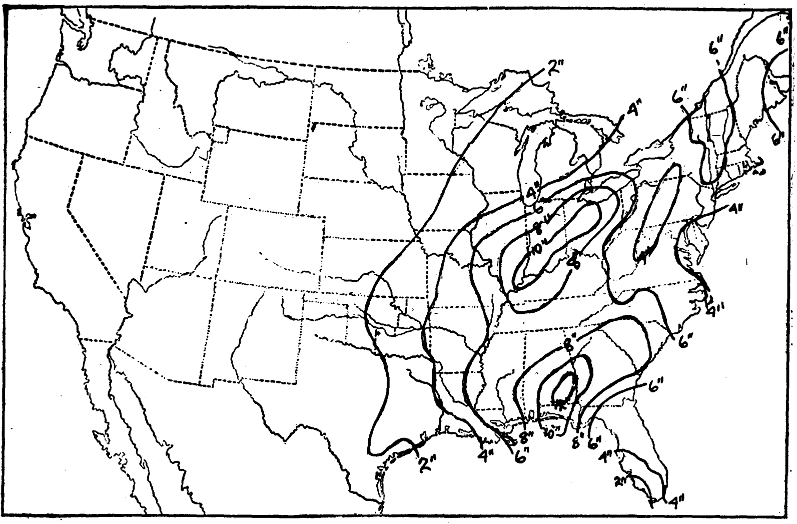

Fig. 2—Rainfall for March, 1913. From the U. S. National Monthly Weather Bulletin.

(*b*) *Columbus, Ohio.* Columbus is situated at the confluence of the Upper Scioto and Olentangy (Whetstone) Rivers which have a combined drainage area of approximately 1,600 square miles. The flood-plains of these rivers within the city cover an area of about nine square miles, a part of which is densely populated.

The Scioto River winds through this flood-plain, making two sudden turns where the river impinges against the eastern bluffs. The populated portion of the city is protected by a levee which extends along the west bank of the river for a distance of seven miles. The highest flood in previous years was in 1898 with a gage height of 21.3 feet, and the levees had been extended to 6 feet above that mark. The Weather Bureau records give, for the maximum stage during 1913 on March 25th, 22.9 feet. The discrepancy between the height of the levees and the height of the flood during 1913 must be explained by the release of the water higher up the Scioto River after the overtopping of the levees, which caused a number of breaks, and by the position of the gage below the first of the sharp bends of the river where one or two bridges constrict the channel. The rainfall at the headwaters of these two streams was similar to that reported for the Miami River. The Scioto has a tributary rising near Bellefontaine so that the rainfall of 11.16 inches during the period from March 23d to 27th overlapped both drainage basins. In addition Marion had a rainfall for the same period of 10.71 inches, and at Columbus the precipitation was 6.97 inches.

As in the Dayton flood the damage to railroad lines was particularly heavy. The levees at Columbus were in part used as a track-way, and the breaking of the levees tore away many sections of the road. The Baltimore and Ohio Railroad in the Ohio flood district reports a loss of between $2,500,000 and $3,000,000, including the destruction of twelve bridges, and the ''Big Four'' (Cleveland, Cincinnati, Chicago and St. Louis Ry.) reports forty bridges destroyed and from twenty-five to thirty miles of tracks washed away.

The houses on the flood-plain area of Columbus were largely wooden structures, and in places the water reached above the second story. About 30,000 people were driven from these homes by the breaking of the levees, and eighty-five lives were reported lost. The estimate of damage made by the Columbus Building Department is 300 houses wholly destroyed, 200 houses badly damaged, and a loss of personal property, altogether aggregating $1,500,000.

(*c*) *Indianapolis, Indiana.* This city is situated at the confluence of the West Fork of the White River and Fall Creek. The story of the river and the location is similar to that of Dayton and Columbus. The river makes one or two sharp bends in the center of the city, and at one of these the channel is restricted by the piers of bridges. It is, however, unjust to give as the cause of these floods this evidence of crowding the natural flow of the rivers when the rainfall easily explains the high stages. As in Ohio the ground in Indiana was saturated with moisture when the two storms of March 23-27 broke, and in consequence the percentage of run-off was high. At Indianapolis, for the twenty-four hours ending at 8 a.m. on the 23d, the precipitation was 0.16 inches, on the 24th, 1.52 inches, on the 25th, 3.40 inches and on the 26th, 0.46 inches.

On the 26th snow and sleet fell. Previously, on the 21st, 0.46 inches of rain had fallen. The region of the heaviest rainfall was not, however, in the West Fork drainage basin but to the south of Indianapolis and over the East Fork basin. At Indianapolis the precipitation during March 23-27 was 5.54 inches with a total rainfall for the month of March of 7.76 inches, 3.75 inches above the normal for the month.

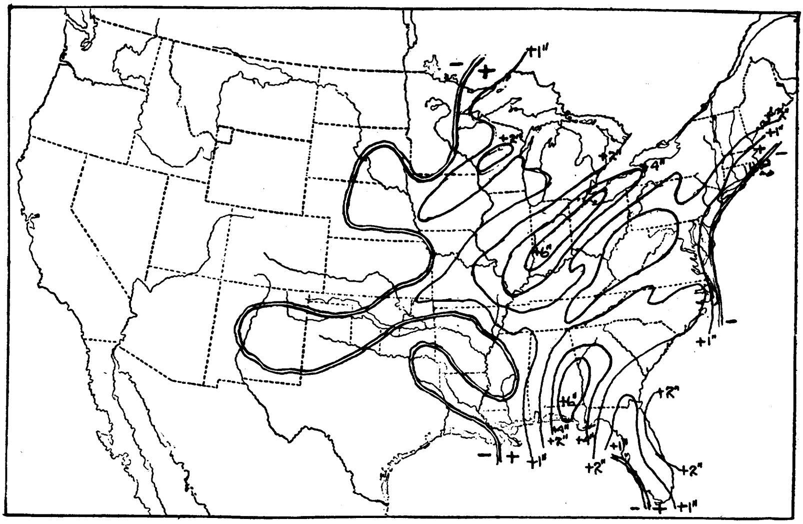

FIG. 3—Departures from the normal rainfall for March, 1913. From the U. S. National Monthly Weather Bulletin.

The highest stage of the river ever recorded previous to 1913 was during March, 1904, when the gage reading reached 21.3 feet. This year the river rose to 25.7 feet, 4.4 feet above the 1904 record.

The area flooded was a long narrow strip mostly on the west bank of the river and averaging about a mile and a quarter in width. The average depth of water over the flooded area was from 10 to 12 feet, and many places had a much greater depth of water.

The damage has been estimated at $2,000,000 for property owners and industrial plants and at $1,000,000 for the railroads and public utilities. Here, as in many other places, the water supply and the sewage system were temporarily deranged. The water supply in Indianapolis was interrupted from noon on Tuesday until the morning of Friday. Railroads, which in many instances parallel the river and frequently cross it, lost heavily by the flooding of the road-bed and the damage to the bridges.

*Two Floods at Pittsburg, Pa.* During 1913, Pittsburg was visited by two floods which exceeded the 30-foot stage. The record flood for this city is 35.5 feet, which occurred on March 15, 1907. The danger line is 22 feet on the Pittsburg gage. On January 9, 1913, the gage height read 31.3 feet, and this is the first time on record that a January flood exceeded the 30-foot stage.

As is shown in Fig. 4, a much larger rainfall than the normal was experienced in western Pennsylvania for the month. The departure from the normal was above plus 2 inches. Pittsburg had a total rainfall for the month of January of 5.28 inches, with a normal of 2.87 inches.

The storm which caused the flood occurred on January 6-9, and an average precipitation of about 2 inches fell over the basins of the two main contributing streams. To the north over the Allegheny basin there was a snow cover of from 1 to 5 inches which the high temperatures accompanying the storm quickly turned to water. The crests of the Allegheny and Monongahela floods united at Pittsburg and caused 700 acres of the low land within the city limits to be submerged.

The second flood occurred on March 28, 1913, when a stage of 30.4 feet, 8.4 feet above the danger line, was reached. The storms which caused this flood were the storms which resulted in the heavy floods over Ohio and Indiana. For the days of the storm, March 24-28, the rainfall at Warren was 4.0 inches, Parker 4.9 inches (both in the Allegheny basin), and Pittsburg 3.3 inches. The Monongahela basin did not receive a heavy precipitation; this prevented the flood from being the record high water. The result of this flood in Pittsburg was the submerging of about 650 acres of city land to a depth of about eleven feet. One-half of this was settled by industrial plants, while another portion was made up of residential and mercantile sites. Altogether eight miles of railroad tracks were flooded.

Two floods of such heights in a single season is a new record for Pittsburg. During February and March, 1908, floods of 30.7 feet and 27.3 feet respectively were experienced, and this has been the record until the present year.

*Stages on the Ohio River.* The progress of the January and March floods down the Ohio and Mississippi was marked by unusually high stages, by the flooding of cities and, along the Mississippi River, by the breaching of the levees.

At Wheeling, West Virginia, 90 miles below Pittsburg, the first crest reached a stage of 44.6 feet on January 9th. This is 8.5 feet below the record flood which occurred during February, 1884, but it was 8.6 feet above the danger line. This flood drove 600 families from their homes. On March 28th, a stage of 51.1 feet was recorded, 2 feet below the record, and 6.5 feet above the January flood.

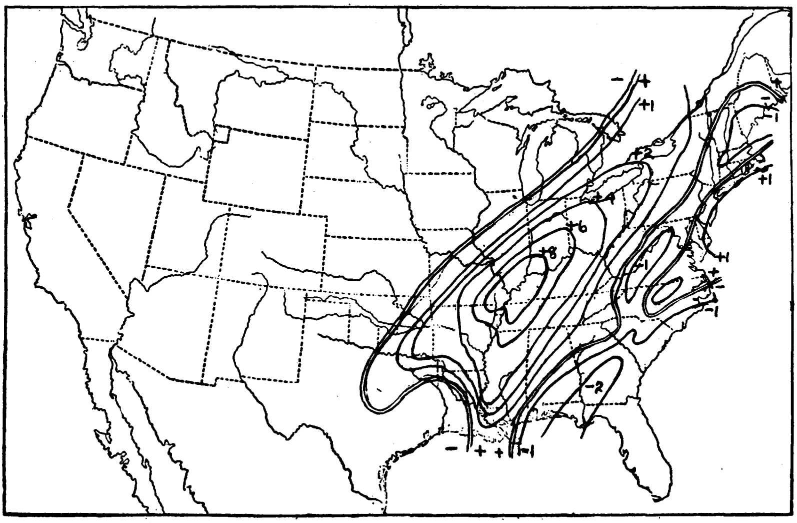

Fig. 4—Departures from the normal rainfall for January, 1913. From the U. S. National Monthly Weather Bulletin.

At Cincinnati, Ohio, 468 miles below Pittsburg, the danger line of 50 feet was crossed on January 10th; on the 11th the river went to 54 feet, when the Grand Central Station became useless; the crest passed on the 15th with a stage of 62.2 feet. The February, 1884, flood reached a height of 71.1 feet. During the January, 1913, flood, 3,000 families were driven from their homes, and an estimated loss of $2,000,000 has been given out by the city authorities. The March flood of 1913 exceeded the January flood by 7.6 feet and lacked 1.3 feet of reaching the record stage.

The 1884 flood was of brief duration while the 1913 flood had a much flatter crest, and the high stage of 68 feet lasted at this city from Sunday, March 30th, until Thursday, April 3d, and the volume of water during this year's flood probably exceeded any other.

At Cairo the 1912 flood made a new record of 54 feet, which is 9 feet above the danger line. The March, 1913, flood exceeded this record by 0.7 feet, making the new record at Cairo of 54.7 feet.

TABLE III

STAGES OF THE OHIO RIVER (Elevations in Feet)

| | Maximum Flood | Danger Line | 1912 | 1913 | |
|---|---|---|---|---|---|
| | | | | Jan. | Mar.-Apr. |
| Pittsburg, Penn. | (1907) 35.5 | 22 | 28.1 | 31.3 | 30.4 |
| Wheeling, W. Va. | (1884) 53.1 | 36 | 38.4 | 44.6 | 51.1 |
| Cincinnati, O. | (1884) 71.1 | 50 | 53.4 | 62.2 | 69.8 |
| Louisville, Ky. | (1884) 46.7 | 28 | 28.7 | .... | 45.0 |
| Cairo, Ill. | (1912) 54.0 | 45 | 54.0 | .... | 54.7 |

*Protection from Floods.* Newspapers and magazines have been teeming with advice since the disaster in Ohio, and the consensus of opinion as expressed by many of the articles is that reservoirs and reforestation must be resorted to as a means of protection and also that the levees are not sufficient.

Notwithstanding, there is little doubt that the country is committed, and justly so, to a levee policy for the protection of the lowlands along the rivers. It will be necessary to build the grade of these levees higher and higher for a number of years unless some counteracting project, as large reservoirs, be built to lower the flood crest. It is doubtful if any of the remedial policies would have prevented damage during the recent floods. Reservoirs would have been full, forested areas would have been saturated before the heavy rainfall which caused the disaster broke over the area. The levees were sufficient for any known stages of the rivers, although some carelessness in the use of the levees and the treatment of the stream channels is charged against the railroads and municipalities. English engineers have advocated a policy of protection against the normal flood and have not considered it either profitable or desirable to build structures against an abnormally high stage. Under this heading fall the Ohio floods of March, 1913. They were the result of unprecedented rains. Shall the cities plan to raise the levees 2 to 3 feet above the newly established grade of an unusual flood? Shall reservoirs be constructed to hold the excess of water above the danger stage of the highest known flood? The engineers of the Mississippi River state that the Ohio, Upper Mississippi, and Missouri Rivers have never been known to have been in extreme flood simultaneously, and they assert it is unlikely that high stages of these three large feeders to the lower river should occur at the same time. Should such an event occur, the volume of water discharged to the Lower Mississippi would greatly exceed any anticipated stages of the river. Somewhat guardedly, perhaps, the possibility of such an occurrence is admitted. Shall the heights of the levees be adapted to withhold this possible volume of water? The policy of the Mississippi River Commission, although not stated in print, may be inferred from the projects to take no account of such a contingency, and, tacitly, at least, it stands for protection against normal or great floods but not against floods of unprecedented conditions. Some protective measures, however, should be adopted to prevent fatalities in unusual cases.

There is no excuse for loss of life in these floods. Because the Mississippi floods move over so great a distance, the crest height can be accurately predicted for many stations a few days in advance, and ample warning reaches every area of the alluvial basin. In recent years the death toll on the lower Mississippi has been a negligible quantity, and in most cases where a loss of life has been reported the cause can be traced only indirectly to the overflow. In the Ohio cities no such warning is possible, as the flood follows closely on the precipitation.

It will be a questionable policy, however, to permit the rebuilding of dwelling houses on the areas subject to overflow. City parks and playgrounds, storage house and mercantile plants are more fitted for the flood-plains bordering most rivers, and certainly it is as much a function if not a duty of municipal prudence to forbid its people to dwell in areas subject to overflow without warning as it is to protect them from violence or fire.

Again, it will not be possible to protect within any reasonable expenditure property from such unusual conditions as occurred in Ohio and Indiana. The risk and sometimes the destruction of property is the tax which must be paid for the occupation of many of these valuable sites.